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The Journal of HEREDITY

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VOLUME 25 FEBRUARY, 1934 NUMBER 2

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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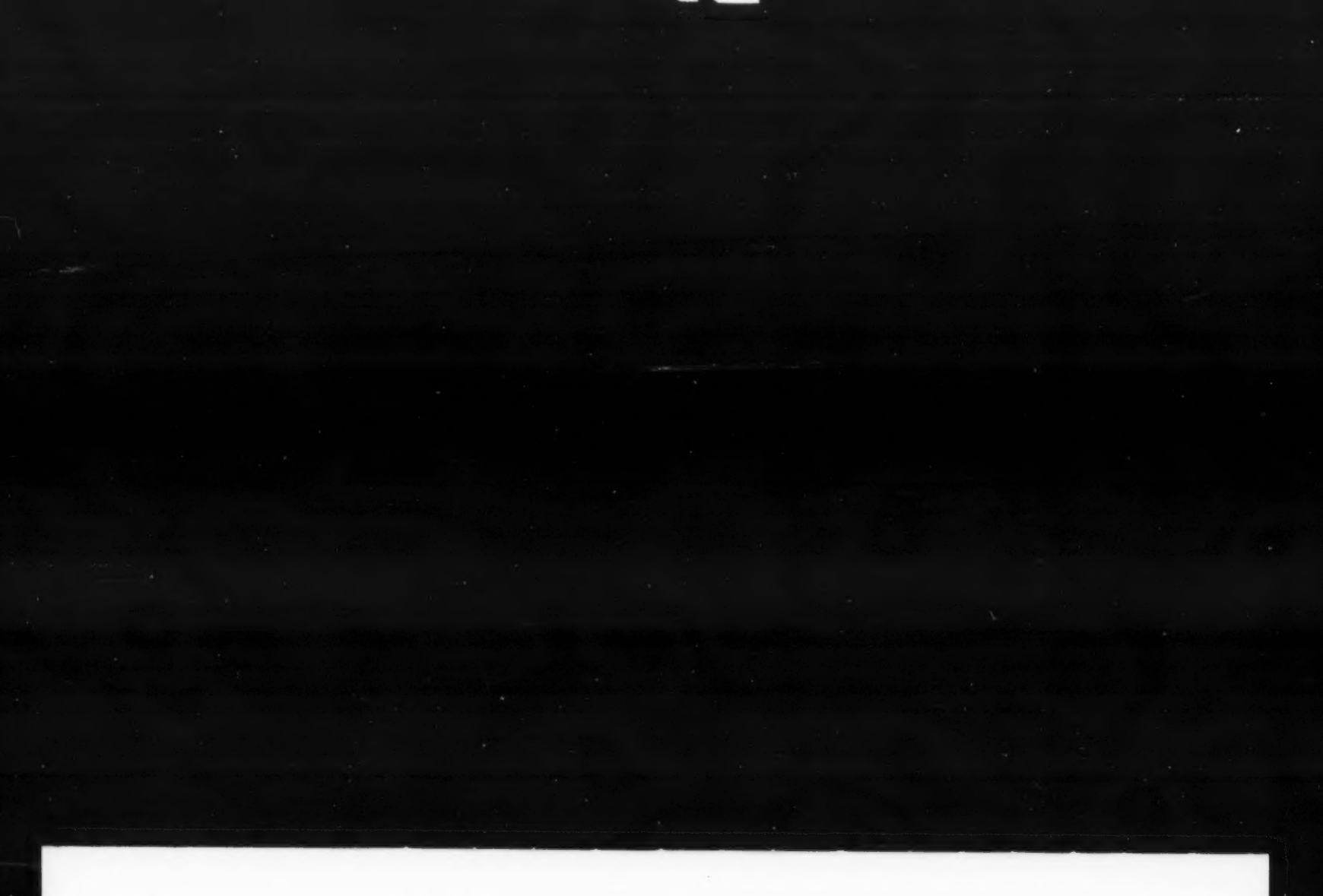

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COMING

New facts, like new veins of ore, are sometimes found in the most unexpected places, and the scientist-miner must be continually on the alert to discover the faint surface intimations of such hidden treasure. An instance of such a "hidden outcrop" was a single abnormal Jimson Weed plant discovered in 1915. A study of this "freak" initiated a series of brilliant discoveries that has culminated, after nearly twenty years, in the production of "artificial new species." In the next issue of the *Journal* Dr. A. F. Blakeslee will discuss some of the more important facts which this research has brought to light. Thirty-five illustrations show the developmental changes produced, not by single genes, but by extra chromosomes and parts of chromosomes. He explains how the extra chromosomal material was put up in new packages to produce true-breeding forms whose distinctive characteristics justify the designation "laboratory species."

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STRIPING TRANSMITTED ONLY THROUGH FEMALE LINE

Frontispiece

The male parent plays no part in the inheritance of this form of striping in sorghum. Only striped mother plants transmit striping, their progeny being green, striped, or yellow depending upon the striping pattern of the panicle on which the seed was borne. From all-green panicles only green plants are produced, regardless of the type of pollen used. If the panicle happens to be all-yellow only yellow progeny are obtained even though pollen from a green plant is used.

MATERNAL INHERITANCE OF CHLOROPHYLL IN SORGHUM

R. E. KARPER
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A NUMBER of plants conspicuously striped with chlorophyll deficient areas have, in recent years, appeared among different strains of sorghum. These have been found in several varieties of sorghum and are of two distinct types—variegated green and white and variegated green and yellow. So far as type of inheritance is concerned, these two types are identical. Transmission of the character to the offspring is strictly maternal and its inheritance is not carried through the male gametes. Striped plants produce normal green, striped green and yellow or green and white, and pure yellow or pure white seedlings. The green plants produce normal green offspring, the yellow and the white plants die in the seedling stage, and the striped plants again repeat the performance of the parents.

The first chlorophyll deficient type of this character in sorghum was a single green and yellow striped plant observed in a plat of Sunrise kafir at the Lubbock Station in the fall of 1927. Preliminary trials with seed from this plant gave normal green, striped green and yellow, and yellow seedlings in perplexing proportions which did not indicate any of the common Mendelian ratios. Following Anderson's[1] ingenious method it was found that when seed from certain sections of the head were planted separately the three kinds of progeny were not randomly distributed but were borne on definite areas on the head. Seed of this stock was planted the next year and a number of striped plants secured for further investigation. The chlorophyll deficient areas on the leaves of striped plants are yellow when the plants are young but fade out to white toward maturity.

Similar cases of maternal inheritance have been reported in *Antirrhinum* by Bauer,[2] in *Mirabilis* by Correns,[3] and in *Primula* by Gregory.[5] More recently, Anderson,[1] and later, Demerec,[4] described independent cases of maternal inheritance of chlorophyll in maize, and in the latter paper a rather complete review of the literature on this subject is given. Maternal inheritance of chlorophyll in sorghum discussed in this paper is, for the most part, quite similar to that described in maize by the above writers.

Behavior of Variegated Plants

Sorghum seed are borne on seed-branches arising at nodes on the rachis and more or less uniformly distributed throughout the length of the panicle. In order to establish the fact that the chlorophyll deficient types arise from definite areas, rather than being distributed at random on the head of striped plants, seed from several selfed heads were planted in flats according to the arrangement of the seed-branches and nodes in the head. Figure 1 illustrates the distribution of the green, striped, and chlorophyll lacking seedlings in the progeny of a selfed head of Hegari. The variegation in this case was green and white and the seedlings produced were green, striped green and white, and pure white. The green and yellow striping in kafir, previously mentioned, behaves in exactly the same way except that the striped seedlings are green and yellow and the chlorophyll lacking seedlings are pure yellow. The seedling progeny of this striped plant of Hegari consisted of 989 green, 8 striped, and 92 white seedlings. Not only are the abnormalities not distributed at random on the parent head but there is a direct correlation between the nature of the maternal tissue and the kind of seedlings it produces. Furthermore, the pattern outline of chlorophyll deficient tissue in the parent head can be observed and

the nature of the offspring predicted rather closely, though not exactly. Each seed-branch of a head from a green and yellow striped kafir plant was marked at ripening time as either green (*G*), striped (*S*), or yellow (*Y*), according to the appearance of the maternal tissue at time of examination. Upon planting each seed-branch separately it was found that the kind of seedlings produced was in general agreement with the description of the parental tissue (Table I). Some of the seed-branches described as green gave striped and yellow seedlings and some gave only yellow seedlings, but in every case where the parent seed-branch was designated as yellow, only yellow seedlings were produced. That some of the seed-branches designated as green and striped produced only yellow seedlings may be due to the fact that the sub-epidermal tissue from which the female gametes originate does not correspond exactly in hereditary constitution with the epidermal tissue on which the classification is based.

Striped plants were found to vary widely in the intensity of the chlorophyll deficient area involved and may have a preponderance of either green or chlorophyll deficient area or a rather even division of the two (Frontispiece). Those preponderantly chlorotic grow slowly and some may die, while others largely green produce practically normal plants at maturity. In some cases only a few narrow stripes appear on the lower leaves and the head, which is not affected, produces only normal green seedling progeny. In others, the upper leaves, and panicle are entirely involved in the deficient area and all their seedling progeny are wholly deficient in chlorophyll and die. Some plants show a fairly even division of normal and chlorophyll deficient tissue on the lower stem and leaves but the deficient area increases in the upper leaves and stem, involving the whole of this part of the plant. Seed set on such a plant produce only seedlings which die. Table II shows the extreme variation that may be found among striped plants as measured by the kinds of seedlings they produce and the percentage of normal green offspring.

Character Not Transmitted Through the Pollen

When the chlorophyll deficient area extends to the panicle its path through the head is readily visible and the individual florets affected can be seen before blooming occurs. Pollen collected from flowers in a region devoid of chlorophyll was used to fertilize normal green flowers of milo, another variety of sorghum. Six F_1 seed produced only normal green plants and 75 seedlings reared in the F_2 generation were likewise normal, showing that the male gametes do not transmit the variegation to the progeny. Conversely, reciprocal hand crosses, where pollen from normal green milo was used to fertilize flowers involved in the chlorophyll deficient area of the panicle of a striped plant, resulted in seven F_1 seed that gave only lethal yellow seedlings.

Random pollinations were also made by dusting the pollen from striped kafir plants on normal green milo plants.

TABLE I.—Seed-branches from each node of a head from a striped plant were marked as being green (*G*), striped (*S*), or yellow (*Y*) according to the phenotypic appearance of their tissue. Figures show per cent of green, striped, and yellow seedling progeny produced by each seed-branch.

Node No.	Seedbranch number					
	1	2	3	4	5	6
1	S 17:22:61	G 0:0:100				
2	G 0:0:100	G 18:3:86	G 78:2:20	S 9:3:88	Y 0:0:100	G 11:6:83
3	Y 0:0:100	G 66:14:19	Y 0:0:100			
4	S 8:3:92	S 0:0:100	Y 0:0:100	Y 0:0:100		
5	S 20:0:80	S 0:0:100				
6	Y 0:0:100	S 0:0:100	S 0:0:100			
7	S 4:0:96	S 19:5:76	Y 0:0:100	S 0:0:100		
8	S 0:0:100	Y 0:0:100	G 10:10:80	S 0:0:100	Y 0:0:100	
9	Y 0:0:100	S 5:5:90	S 0:12:88	G 16:26:58	Y 0:0:100	
10	S 0:0:100	G 33:17:50	S 6:9:86	Y 0:0:100		

Head No.	Number of seedlings			Percent green
	Green	Striped	Yellow	
1	979	8	32	92.80
2	537	37	88	83.64
3	112	34	1014	9.66
4	7	0	302	.23
5	1	0	623	.02

TABLE II. — Variegated plants vary widely in the area of chlorophyll deficiency involved as shown by the proportion of the three classes of seedling progeny.

DISTRIBUTION OF STRIPED SEEDLINGS

Figure 1

Pattern of distribution of green, striped, and yellow seedlings when the seed branches are planted according to their location on the panicle. The seeds from each seed-branch are separated by the wooden stakes. It is seen that some branches produced only green seedlings; some produced green, striped, and yellow seedlings; and some produced predominantly yellow seedlings.

Fourteen F_1 hybrids, identified on the basis of hybrid vigor, resulting from this pollination were normal green and the F_2 seedling progeny of 710 were also all normal green. Reciprocal crosses made in the same way produced 43 F_1 hybrids, all of which proved to be normal green, and an F_2 progeny of 21,450 normal green seedlings. In view of the results of the controlled pollinations we should expect this latter cross to have produced some striped or completely chlorophyll deficient plants among the F_1's. That none of these appeared is probably due to the fact that none of the F_1 seeds was borne on chlorophyll deficient or transitional tissue. Unfortunately, no notes were made on the distibution of the chlorophyll deficient tissue in the parent plants of the random crosses.

In both the controlled crosses and the random pollinations, however, the evidence seems clear that the male gametes do not transmit the variegation to the progeny.

Among the first-year progeny of the original yellow and green variegated plant of kafir there were 73 normal green plants. No striping appeared on the leaves and they were grown to maturity for further observation of their progeny. In the greenhouse the following winter 72 of these heads produced a total of 11,940 seedlings, all of which were pure green, but one of the heads produced 488 green and 27 white seedlings. White seedlings were not heretofore known in this stock, and since new chlorophyll mutations have previously been found in sorghum rather frequently (Karper and Conner[6]), this was believed to be merely another albino, segregating in a 15:1 ratio, and governed by two recessive factors instead of one. Further trials with this stock, however, indicate that this is not a chlorophyll character involving duplicate factors. Among 41 plants grown from remnant seed of this stock, 28 of them had albinos among the progeny of the next generation and 13 produced all green seedlings. The ratio of green to albino seedlings in the 28 segregating individual heads varied widely, from 8:1 to 27:1, and no 3:1 ratios were obtained as would be expected in this generation if either duplicate factors or only a single factor were involved. Differential viability, or failure of appearance of individuals in the albino class through lack of germination, does not explain the situation since the proportion of green and white seedlings in the 28 segregating heads was further verified by planting 100 seed of each. All lots averaged 92 per cent germination and 6.87 per cent of the seedling progenies were albinos. The same wide variation in the percentage of white seedlings was found but none approached a 3:1 ratio, even if the seeds which failed to germinate were all credited to the recessive class. The following year one of the parent plants which segregated 43:1, and also one which segregated 10:1, were planted for testing the tendency of their daughters to reflect similar high or low percentages of white seedlings in the next generation. No such tendency was apparent, as the former showed a ratio of 9.6:1 of greens and of albinos among its segregating progeny while the latter had a ratio of 15.1:1, the parent with the higher proportion of albinos showing the lower proportion in the progeny. The wide fluctuations in the percentage of white seedlings and their failure to conform to usual Mendelian ratios suggested that white seedlings might have a positional relationship to certain regions on the parent head, even though these parental plants appeared normal green without any chlorophyll deficient areas such as characterize the striped plants formerly in this stock. Seed-branches from various nodes were, therefore, planted separately in flats and arranged so as to indicate the pattern arrangement, if such existed. Fourteen heads handled in this manner gave approximately the same variation in percentage of white seedlings among the progeny but showed no relation to position on the parent head, the distribution of the albinos being apparently at random.

In view of the behavior of this chlorophyll deficiency, it appears quite unlikely that it is an ordinary Mendelian character. Neither does its behavior conform to that of the maternal inheritance of chlorophyll deficiency in the striped and yellow plants previously studied in this same stock, but these white seedlings probably have some connection with the cytoplasmic disturbance caused by the former.

A Segregating Yellow

Among the 41 green plants which gave a highly variable number of albino seedlings in their progeny, one of them was also segregating for yellow seedlings. This progeny had 509 green, 164 yellow, and 51 white seedlings, and also a single seedling that was green striped with yellow. Selfed plants from this stock produced, in the following generation, four types of progenies as follows: (1) all green; (2) segregating yellow; (3) segregating white; (4) segregating both yellow and white. The percentage of white seedlings among any given progeny showed the

same unaccountable variation, but when the yellow seedlings alone were considered in all the progenies segregating for this character, there was found to be a total of 7,544 normal green and 2,317 yellow, a deviation of 148±29.0 from a 3:1 ratio. This small but apparently significant deviation may be due to any one of a number of factors but it is quite clear that yellow seedling color is governed, in the main, by a single recessive factor. Furthermore, the seeds producing yellow seedlings were found to be distributed at random on the parent head. Apparently the yellow seedling character came into this stock as a new single gene mutation. The green seedling striped with yellow died but no others of this character appeared in the next generation. Therefore, the nature or cause of this single specimen cannot be explained.

Other Similar Cases in Sorghum

In addition to the two cases described, numerous other sorghum plants having the same general characteristics have been observed within the past few years, indicating that such variations are not uncommon in this species. A number of these have been collected by Mr. D. L. Jones and Mr. Frank Gaines who kindly preserved them for investigation. While not all of them have been tested, five additional plants which were carried through preliminary trials appeared to be typical cases of maternal inheritance similar to those already described. These variations were found in the several varieties of sorghum, kafir, milo, feterita, and Hegari, and in one case the variegated plant appeared among the progeny of an inbred line of kafir that had been selfed continually for 15 years.

Discussion

Aside from the numerous chlorophyll characters in plants which follow the regular Mendelian type of inheritance, many others have been reported which are passed on from generation to generation only through the mother. This latter type of inheritance, in which the pollen is not concerned in the transmission of the character, is known as maternal or cytoplasmic inheritance. That this chlorophyll character in sorghum is strictly maternal in mode of transmission from one generation to the next, is borne out by the fact that only seeds produced on the chlorophyll deficient areas give yellow or striped progeny; that the pattern of soma in the panicle determines whether certain flowers will produce normal or abnormal offspring; that flowers in the abnormal area produce only abnormal plants, even when fertilized by pollen from normal green plants; that normal plants pollinated with pollen from florets in abnormal areas produce only green plants, and, finally, that the character does not reappear later in the progeny of such a cross.

Correns and Bauer, in describing similar cases of maternal variegations in *Mirabilis* and *Antirrhinum*, assigned the cytoplasm of the egg as the vehicle of transmission of the character. Some investigators go further and assume the plastids themselves as the carriers of this type of inheritance. Although conclusive evidence is lacking, such an assumption fits the facts very well in cases of this kind and is the generally accepted view. Plastid primordia are passed on to the progeny through the cytoplasm of the egg, and since the plastids normally condition chlorophyll development, the progeny are normal. Egg cells formed from tissues devoid of chlorophyll, however, contain only plastids incapable of bringing about chlorophyll development. Seed formed from fertilized egg cells of this kind produce only seedlings devoid of chlorophyll like the maternal tissue. When egg cells are formed from mixed green and colorless maternal tissue, the multiplication of the two kinds of plastids in the progeny results in a variegated, or striped, plant. The nature of the progeny in this type of inheritance, therefore, depends upon the nature of the maternal tissue rather than upon the chromosomes.

Certain complications involving the sudden appearance of other kinds of

chlorophyll deficiencies in cultures being studied in connection with maternal inheritance of chlorophyll in sorghum are rather puzzling and cannot be satisfactorily explained. In the present case, white seedlings which apparently do not follow regular Mendelian inheritance appeared among the green plant progeny of a green and yellow striped parent which otherwise followed the normal behavior of maternal inheritance of chlorophyll. The new chlorophyll character, white seedlings, bears no resemblance to the yellow seedlings or yellow striping in the maternally inherited chlorophyll deficiency. The percentage of albinos among various progenies fluctuates widely and does not approach normal Mendelian ratios expected in the F_1 or F_2 to satisfy the assumption of single or duplicate factors.

Another chlorophyll character, yellow seedlings, appeared in the same culture of green plants in which the white seedlings were already present. In the same progeny with the yellow seedlings was found also one green and yellow striped seedling resembling the original striped chlorophyll deficiency inherited maternally. Thereafter, through two generations, the yellow seedling character behaved strictly as a simple Mendelian recessive and no striped seedlings appeared among the progeny.

The appearance of the yellow seedlings in this culture may be explained as the result of a new mutation but the white seedlings and striped seedlings are not so easily disposed of. It seems probable, however, that these additional chlorophyll deficiencies may have some connection with the cytoplasmic disturbance responsible for the peculiar inheritance of the maternal type. Anderson, who also found albino and yellow seedlings among the progeny of green plants from maternal inheritance stock, assumed that the off-type plants were probably due to mutation.

Summary

1. Two types of striped plants, green and yellow, and green and white, which have appeared independently in various cultures of sorghum, are described. These types of chlorophyll deficiency are transmitted only through the female.

2. Variegated plants give normal green, striped, and yellow or white progeny in accordance with the location of the parent seed in relation to the chlorophyll pattern of the panicle. Green plants produce green progeny, yellow or white seedlings die, and striped plants repeat the behavior of the parent.

3. Flowers from an area lacking chlorophyll produce only yellow or white progeny, whether self-fertilized or pollinated with pollen from a normal plant. Normal flowers, fertilized with pollen from the chlorophyll deficient area, give only normal plants.

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MENTAL AND PHYSICAL TRAITS OF IDENTICAL TWINS REARED APART

Case VIII. Twins "M" and "R"

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THIS case study deals with a pair of girl twins 16 years old when examined. It is one of the most interesting and significant of our cases because the chief environmental difference is one of an intellectually stimulating home environment versus a home environment lacking almost all intellectual stimulus.

The Environments of "M" and "R"

The mother died three months after the birth of the twins, and the latter were at once separated and adopted by two families of relatives.

M was adopted by and reared in the home of a brother of the twins' mother. She has always lived in a town of about 5,000 inhabitants with the family of a man locally very prominent, a bank president and former mayor of the town. He is a lawyer and a remarkably well-read man, and interested in discussing problems of the day. *M*'s foster mother has had only a high school education, but has considerable interest in intellectual and cultural pursuits. *M* has also had the advantage of having an older sister living in the same family and studying music with her. Both these girls are good musicians, *M* playing violin in the high-school orchestra. Next door lives the sister of *M*'s foster mother, who is a graduate (Phi Beta Kappa) of one of the leading universities and is now a teacher in the high school. This lady has always taken an active interest in *M*'s education, though not tutoring her. *M* has always been encouraged to be a good mixer and she has always played with large groups of children. There have always been well chosen books available in abundance and *M* has been an inveterate reader. On the whole then *M*'s home environment has been unusually broadening and stimulating. *M* is now in grade 10A in high school, one half grade ahead of *R*. There can have been no great difference in the quality of instruction in the two schools, *R*'s school being one of the best in the state of Indiana.

R was given a home in the family of a brother of *M*'s foster mother. It is only within the last year or so that she was legally adopted. *R*'s foster parents have had relatively little education, the father having had only part of a high school education and the mother only a very limited grade school education and no cultural education. The foster father was, until his death about a year ago, a foreman over day laborers. He has not been interested in inteliectual or cultural matters. *R*'s foster mother is said to be jealously fond of *R*, and since her husband's death, has kept *R* more closely than ever at home. *R* has led a rather lonely life, playing with dolls rather than with other children. There have been no other children in the family. She has had few friends and has engaged little in group activities. There has been no good music of any sort in *R*'s home, but she has taken some music lessons. There have been few good books accessible to *R* in her home. Her home life has been anything but broadening or stimulating; quite the contrary.

Medical Histories and Personal Differences

There is little difference in the health record of the two girls. *M* weighed 6 pounds at birth and *R* only 3½ pounds, but they soon grew to be of about the same weight. Both had the ordinary children's diseases early in life. *M* had a mild attack of infantile paralysis at four years, the only apparent after-

THE FINGER PRINTS OF *M* and *R*

Figure 2

These finger prints afford in themselves an excellent criterion of monozygosity. One depends not so much upon a correspondence in the finger-print formulae in forming a judgment concerning monozygosity as upon close correspondences in details of pattern between homologous fingers of two individuals. Note especially the striking resemblance between digits I and III of the two left hands and digits I, II and IV of the two right hands. Also note that in each individual the only loops are on digits I and IV of the two left hands.

effect being that one leg is half an inch shorter than the other. Both twins have a pronounced tendency to constipation, verging on faecal obstruction. Both have pronounced crossing of one eye, in spite of wearing glasses to correct the defect. *M*'s right eye turns in and *R*'s left eye turns in, a curious mirror-imaged type of strabismus not uncommon in identical twins. *M* was somewhat left-handed as a young child, but now does everything with her right hand. *R* has always been right-handed. *M*'s teeth are soft and have decayed quickly, at least a dozen cavities having been filled. *R*'s teeth are also poor, but are now in a little better condition than *M*'s. Both girls are muscularly clumsy, but *M* has engaged in sports much more than has *R*. Both of them are the despair of their respective teachers of physical culture. At the present time *R* speaks with a pronounced lisp, which seems to be quite lacking in *M*. *M* is much more friendly, talkative, and free from timidity. *R* is painfully shy and seems far less happy than does *M*. *M* takes the lead in everything and is much more aggressive. The two girls have been reared entirely apart except for occasional short visits.

Proof of Monozygotic Origin

Physically *M* and *R* are as similar as the average pair of identical twins reared together. Their facial appearance is unusual but the same in both. Hair-color, eye color, ear form, complexion, features, etc., are alike. The teeth of both are small and widely spaced in front. There is only ¼ pound difference in weight, less than 2 cm. difference in height, and all other physical measurements are very closely similar, the largest difference being in head width, *M*'s head being 1 cm. wider. The physical data are given in Table I.*

There are several evidences of reversed asymmetry or mirror imaging, which is one important accompaniment of monozygosity. As already stated *M* was left-handed as a child, while *R* has always been right-handed. *M*'s right eye and *R*'s left eye are strongly crossed. *M*'s left hand is wider than her right, while *R*'s are equal. The hair whorls, however, are distinctly clockwise in both.

The finger print formulae are as follows:

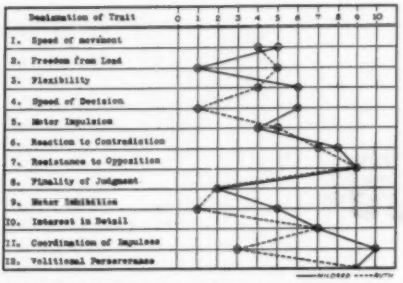
	Left	*Right*
M	U. Wu. Wu. Wlu. U	Wlu. Wlr. W. W. W.
R	U. Wr. Wlu. Wlu. U	Wlu. Wlr. W. W. Wlu.

The two right hands are almost identical, differing only in digit V. The two left hands are more similar than is either left to own right hand. In the left hands of both girls digits I and V show ulnar loops, while all the other patterns in both right hands are whorls.

The quantitative values of the finger prints are as follows:

*TABLE I.—Physical Characteristics of *M* and *R*

	M	*R*
Height	168 cm.	165 cm.
Weight	120¾ lbs.	120½ lbs.
Circumference of fore arm	L, 21 cm; R, 21.3 cm.	L, 21 cm.; R, 21.3 cm.
Head length	18.4 cm.	18.4 cm.
Head width	14.4 cm.	13.4 cm.
Cephalic index	78.2	72.8
Eye color	Hazel	Same
One eye crossed	Right eye	Left eye
Hair color	Light brown	Same
Hair texture	Straight and fine	Same
Hair whorl	Clockwise on right side.	Same, but less distinct.
Ear shape	Large and somewhat protruding.	Same in shape and set.
Features	Somewhat unusual, mouth very wide.	Same
Teeth	Widely spaced and in poor condition.	Same condition—a little better than in *M*.


Designation of Trait
0 1 2 3 4 5 6 7 8 9 10
1. Speed of movement
2. Freedom from Load
3. Flexibility
4. Speed of Decision
5. Motor Impulsion
6. Reaction to Contradiction
7. Resistance to Opposition
8. Finality of Judgment
9. Motor Inhibition
10. Interest in Detail
11. Coordination of Impulses
12. Volitional Perseverance

"WILL-TEMPERAMENT PROFILE"

Figure 3

On four of the twelve items the test indicates rather marked temperamental differences. These perhaps reflect the considerable differences in the emotional environment of these twins.

	Left hand	*Right hand*	*Total*
M	40	43	83
R	43	39	82

The total values of right plus left hands of the twins differ by only one point, closer than that found in any fraternal twins. Also there is present distinct mirror-imaging, the right hand value of *M* being the same as that of *R*'s left.

The palm-pattern formulae are as shown below.* Here *M*'s left hand has the more right-handed pattern and resembles closely *R*'s right hand. Also the right hand of *M* is more like the left hand of *R* than like her own left hand. This is the kind of mirror-imaging found most commonly among identical twins of middle grade resemblance.

All of these criteria combined render the monozygotic diagnosis of *M* and *R* beyond question.

Intelligence Tests

1. *Stanford Binet Mental Test.* Both girls worked faithfully, but *R* was slower, taking 75 minutes, as compared with 67 for *M*. *M*'s total score was 92 as compared with *R*'s score of 77, a difference of 15 points, which is a large difference and nearly 3 times as great as the average of 50 pairs of identical twins reared together. *M*'s mental age was rated at 14 years, 2 months, *R*'s at 11 years, 10 months, a difference of 28 months, over three times as great as the average of 50 pairs of identical twins reared together and considerably greater even than the average difference in 50 pairs of fraternal twins reared together.

2. *Thurstone Psychological Examination.* The total scores in this test were *M*, 74 and *R*, 35, a large difference in favor of *M*. Both scores were low, however, the percentile rank of *M* being 12 and of *R* being 5, both ranking in the lowest quartile. This, however, is to be expected in view of the fact that the examination is designed to test the scholastic aptitude of college freshmen.

3. *Otis self-administering test.* On this test *M*'s total score was 101, that of *R* was 86, a difference of 15 points, which is over three times as great as the average difference of identical twins reared together and even nearly twice as great as that of fraternal twins reared together.

4. *International Test.* On this test *M* was superior in total score, having 193 points to *R*'s 155, which is a large difference. *R*, however, made a slightly higher score on Book I, the simplest part of the test.

5. *Stanford Achievement Test.* The results of this test are given in years and months of educational age. *M* has an educational age of 14 years, 7 months; *R* of 13 years, 6 months. *M* is thus 13 months ahead of *R*. This difference in educational attainment is somewhat lower than might be expected on the basis of the large differences in intelligence ratings found in the previous tests, yet it is a large difference and in favor of *M*.

Summary of Intelligence Tests. All of these tests are consistent in that they

*Palm Pattern Formulae:

	Right hand	*Left hand*
M	9(10).9.7(6).5'-t-Au.O.O.L.V.	11(10).9.5"(6).3-t-Au.O.O.V.V.
R	11(10)-9(10).9.5"(6).4-t-Au.O.O.L.D.	9.O.5".3.-?-O.O.O.O.V.

CHARACTERISTIC DIFFERENCES IN EXPRESSION

Figure 4

The twins *M* (left) and *R* (right) at about eight years of age. This was the only photograph obtainable, but it shows the same differences as are obvious at the present time. *M* is now as then rather brighter and happier in appearance than *R*. Apart from the difference in expression these twins were and are physically as similar as are most identical twins reared together.

show that *M* is at this time much more intelligent than *R*, although there has been very little difference in the amount of formal educational advantages enjoyed by the two girls. The difference is, I think, to be attributed to the great difference in the home environments, already described. The home environment seems to supplement the school environment as an educational factor. Educationalists have, of course, known for a long time that the training acquired through contact with cultured persons is often more effective than the more formal discipline of the class room.

Temperament—Emotional Tests

6. *Downey Will-Temperament Test.* In this test there was a definite contrast with respect to four of the twelve items. *R* shows more freedom from load, which is contrary to what one might expect in view of her general timidity. *M* shows greater speed of decision, higher motor impulsion, and more co-ordination of impulses. The results of the whole test are graphically shown in Figure 3.

7. *Kent-Rosanoff Association Test.* The results of this test indicate rather large differences in temperamental peculiarities between *M* and *R*. Only 7 out of 100 responses are identical. Of the non-identical responses those of *M* are much more like those of the average normal person than those of *R*'s a frequency of only 90. Of which individual responses are given by 1,000 average persons, *M*'s responses have an average frequency of 168 and *R*': a frequency of only 90. Of *M*'s unusual responses only 7 are so uncommon as not to be listed at all among responses given by other persons, while 14 of *R*'s are equaly uncommon. On the whole, then *M*'s reactions are considerably more normal than *R*'s.

8. *Pressy X-O Test of Emotions.* In this test the differences are not so well defined. *M* made a considerably higher score on "effectivity." *R*, as in the former test, gave many more responses that deviate from the usual, or normal, responses. This is particularly evident in Test III in which *M*'s total is much larger than *R*'s, indicating higher emotionality, yet *R*'s deviations from usual responses are much greater than those of *M*. Dr. Freeman interprets these results as meaning that *M* is somewhat more emotional than *R*, but that *R*'s emotional life is peculiar.

The general results of the whole test are as follows:

	M	*R*
Test I (Dislikes)	67	51
Total deviations	6	7
Test II (Associations)	32	45
Total deviations	9	16
Test III (Things wrong)	80	48
Total deviations	13	24
Test IV (Worries)	42	41
Total deviations	14	21
Total score	221	185
Total of all deviations	42	68

It would be fair to say that this test indicates not very large, but probably significant, differences in the emotional life of these twins.

9. *Woodworth-Mathews Test* (*Personal Data Sheet*). In this test *R* gave 14 unfavorable responses not given by *M*, and *M* gave only 6 unfavorable responses not given by *R*. They were identical in five traits that border on the neurotic. *M* gave 63 favorable responses to *R*'s 55. *R* gave 19 unfavorable responses to *M*'s 11. On the whole this test gives results that agree with those of previous tests, are consonant with *R*'s general timidity and reflect her life of comparative isolation from persons outside the family.

Summary of Temperament-Emotional Tests. All of these tests indicate differences of some import in the emotional make-up of the two girls. They all show that *M*'s emotional life is more like that of the average person than is *R*'s, yet both are rather highly emotional. Hence the tests show resemblances and differences, both of which are significant. On the whole I would class these two girls as moderately different in their temperament-emotional traits.

General Summary

This is the first case in our series in which there has been revealed a pronounced difference in intelligence (I.Q.) unaccompanied by an equally pronounced difference in formal schooling. The difference in I.Q. is greater than it was in Case II, where one twin had gone through normal school and the other only through fifth grade.* The only reasonable diagnosis of the cause of this great difference is that the great differences in the informal education of the twins are responsible for the divergent results. *M* lived among well-educated, cultured, and stimulating persons, and had a much more extensive and freer association with persons outside the family; while *R* was kept much more closely at home with foster parents relatively uneducated and unstimulating, and was not encouraged to cultivate many social contacts outside the home. These findings tend to emphasize the educational value of the informal cultural environment of the home superimposed upon the formal discipline of the school.

The social environment has also reacted favorably upon the emotional traits of *M* and unfavorably upon those of *R*. It is obvious to any observer that *M* now has a much more normal attitude toward other persons than has *R*. *M* is relatively well poised, confident, friendly, and receptive, while *R* is ill at ease, timid, and difficult to approach.

Physically both girls are somewhat under par in a number of respects and possess peculiar traits in common. On the whole they are as similar physically as is the average pair of identical twins reared together. This is in contrast with the condition found in five of the previous seven cases already reported.

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* A difference of 12 in I. Q. for the Stanford-Binet Test was also found in Case I. In the description of that case it was stated that the amount of education in *A* and *O* was practically the same. Subsequent correspondence revealed that this statement was inaccurate. These are the facts:—*A*'s schooling, although lasting as many years as *O*'s was much disturbed during the war period, and she attended business college only half days for the last year and a half.

In addition, *A*'s schooling was chiefly along the lines of art and domestic science, while *O*'s training was very similar to that in our best high schools. Thus there was a significant difference qualitatively in the formal education of these twins, facts which help to explain the great difference in their intelligence rating.

LIMITED VALUE OF ANCESTORS' EGG PRODUCTION IN POULTRY BREEDING

MORLEY A. JULL*

IN various parts of the world poultry breeders interested in developing high laying strains have selected their breeding stock from year to year on the theory that the number of eggs laid by a female during her first year of egg production is a good indication of her ability to transmit similar egg laying ability to her daughters. Even when all the dams used for breeding purposes are selected on the basis of having laid at least 200 eggs and the sires used are selected on the basis of their dams having laid at least 200 eggs, a practice which prevails in many breeding establishments, it has been assumed that the dams with the highest individual records are the best breeders. From this it follows that considerable reliance is also placed upon the records of egg production of paternal and maternal granddams of both the sires and the dams used each year. In other words, poultry breeders attach considerable significance to the number of eggs laid by the maternal ancestors of any given bird used as a breeder or sold for breeding purposes.

That the actual number of eggs laid by the dam and by her ancestors and by the sire's maternal ancestors may have relatively little significance in breeding for egg production is demonstrated by the results secured from various matings of sires and dams selected on the basis of their dams having laid a minimum of 200 eggs during their first laying year. In 1928, however, there were a few dams used whose dams or one or the other of whose granddams did not lay 200 eggs. Furthermore, each dam used each year was selected on the basis of having laid a minimum of 200 eggs during her first laying year, which embraced a period of 365 days from the date the first egg was laid.

The results were secured from matings of Rhode Island Red sires and dams at the U. S. Animal Husbandry Experiment Farm, Beltsville, Md., and involve the records of egg production of 701 daughters produced by 15 different sires and 121 dams, which were used as breeders in their yearling year and a few in their third and fourth years.

The 701 daughters were produced during the three years, 1928, 1929, and 1930. All daughters of each dam were placed in the laying house except those physically unfit or those possessing a serious defect or disqualification from the standardbred standpoint. All daughters that were placed in the laying houses in the fall of each year were kept throughout their first year of laying. The only records omitted are those pertaining to birds which died, the mortality amounting to only 9.18 per cent during the three years. The environmental conditions under which the daughters were kept during the three years were as nearly identical as it was possible to maintain. The hatching season each year occurred from March 17 to the first week in May. Housing conditions were identical, the rations fed and the methods of feeding were the same, and the general methods of management were the same. Artificial lights were used in the mornings during the winter months.

In order to determine whether or not the number of eggs laid by the dam bears any relationship to the mean egg production of her daughters, the 121 dams, which were selected for breeding purposes on the basis of having laid a

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minimum of 200 eggs each, have been classified into 9 classes upon range in egg production. The class of lowest producers comprises 16 dams that laid from 201 to 210 eggs each and the highest class comprises 3 dams that laid from 281 to 290 eggs each. The mean of the mean egg production of the daughters of each of the dams belonging to each class is given in Table I, part (1).

Egg Production of Sisters

It has been urged from time to time by practical breeders that a female having a larger number of sisters with high records is more apt to transmit high egg production to her daughters than a female having few sisters with high records or than another female having several sisters with relatively low records. With this in mind, the various groups of full-sisters, each dam being one of a group of full-sisters, have been classified in eight classes according to the mean egg production of each group of full-sisters. The lowest class includes four groups of full-sisters which had a mean egg production of from 166 to 175 eggs and the highest class includes twenty groups of full-sisters which had a mean egg production of from 236 to 245 eggs. Out of the total of 121 dams there were 5 that had been purchased and for which no full-sisters' records were available. The mean of the mean egg production of the daughters of each of the dams belonging to each class of full-sisters is given in Table I, part (2).

Judging from the data given in part (1) of Table I, it is apparent that in this selected group of Rhode Island Red dams there is no significant relationship between the egg production of the dams and the mean egg production of their daughters. The daughters of dams whose egg production ranged from 211 to 220 eggs laid better than the daughters of any other class of dams. In other words, as far as the dams under discussion are concerned, a dam that laid 270 eggs would, on the average, produce daughters that would lay no better than the daughters of a dam that laid 220 eggs. From this it follows that in breeding for egg production poultry breeders who select their dams on the basis of having laid a certain minimum number of eggs are frequently inclined to attach too much significance to the actual number of eggs that each bird lays.

The data given in the last three columns of Table I indicate that the egg production of a group of full-sisters, of which the dam is one, does not serve as an index of the relative breeding worth of the dam. It should be borne in mind, of course, that the various groups of full-sisters whose data are under discussion represent selected groups inasmuch as dams were chosen from among the groups of full-sisters having the highest mean egg production per group of all groups kept each year.

Sire's Maternal Ancestors

Some breeders have placed considerable reliance on the record of performance or production of the sire's dam and paternal and maternal granddams. In an entirely unselected population such a practice probably has considerable value but in a selected group of breeding animals, such as male birds selected from dams that laid 200 or more eggs during their first laying year, the records of the dam and the granddams are apparently of little significance. In Table II data are given concerning Rhode Island Red sires whose pedigrees are available. This record includes the first year of egg production of the sire's dam and his paternal and maternal granddams, together with the mean egg production of his daughters. The data are arranged in the order of the magnitude of the mean egg production of the sire's dam, and his paternal and maternal granddams.

The data in Table II indicate that in this group of selected males the mean egg production of the sire's daughters does not bear any significant relation to the egg production of his dam, nor his paternal or maternal granddam, nor to

the mean egg production of the three female ancestors.

Dam's Ancestry

The great majority of poultry breeders in all parts of the world attach considerable significance to the records of egg production of the ancestors of the dams. It is desirable, therefore, to determine whether or not, in the case of females selected for breeding purposes on the basis of having laid a minimum of 200 eggs during their first laying year, there is necessarily any relationship between the mean egg production of the daughters of a dam and the mean egg production of a dam's dam and her paternal and maternal granddams. Since many breeders in different countries use a minimum of 200 eggs as a basis for selecting females for breeding purposes, it is reasonable to suppose that a similar situation concerning the relationship between the mean egg production of the dams' daughters and the mean egg production of the dams' dams and paternal and maternal granddams would exist in such flocks as exists in the flock of Rhode Island Reds under discussion. In the Rhode Island Red flock whose results are discussed here there were 97 dams with records of egg production available for their dams and paternal and maternal granddams. Data concerning these birds and the 553 daughters produced are given in Table III.

The data in Table III indicate that the mean egg production of the dam and the paternal and maternal granddams of the dam have no bearing on the mean egg production of the daughters of the dams.

Since it has been shown that the mean egg production of the daughters does not bear a significant relationship to the mean egg production of either the sire's or the dam's three nearest female aucestors, it is interesting to determine whether or not the mean egg production of the daughters of each dam bears any relationship to the mean egg production of both the sire's and the dam's three nearest female ancestors. Data on this point are available from ninety different matings of sire and dam and are given in Table IV.

The difference between the first and last means given in Table IV is 19.00, which when divided by the standard error of the difference between the two means gives a value of 2,096. The value of p has been found to be .047, so that the difference between the means is significant since, according to Fisher, any value of p less than .05 indicates significance when small numbers are involved.

Conclusions

Based on the results presented in this paper, it seems safe to conclude that when a minimum first-year record of 200 eggs is used as the basis of selecting breeding stock, the actual number of eggs laid by any bird does not indicate the breeding ability of that bird nor does the egg production of the sire's dam serve as index of the breeding ability of the sire. The egg production of the three nearest female ancestors of sires or dams has been shown in each case to have no significant relationship to the egg production of the progeny. It seems certain, therefore, that in breeding for egg production poultry breeders attach entirely too much significance to the actual number of eggs laid by the different members of their laying flock. On the other hand, the mean egg production of the sire's and dam's three female ancestors has been shown to be slightly significant in its relation to the mean egg production of the daughters of a dam, from which it follows that if the highest producing pullets that are daughters of the highest producing dams are selected as breeders each year over a period of years there should result a gradual improvement in egg production of the daughters produced each year.

These observations do not discount the value of pedigree breeding, which involves recording the ancestry of ev-

ery bird in the flock, because it is only when pedigree breeding work is carried on that progeny testing can be employed whereby progress may be achieved through the results secured from given matings.

Table I. The mean of the mean egg production of the daughters of each of 131 dams classified (1) according to the egg production of the dam, (2) according to the mean egg production of the dam and her full sisters.

(1)			(2)		
Egg production of dams	No. of dams	Mean egg production of daughters	Range in Mean egg production of full-sisters	No. of dams	Mean egg production of daughters
201 - 210	16	188	186 - 175	4	210
211 - 220	14	208	176 - 185	8	211
221 - 230	25	192	186 - 195	13	189
231 - 240	14	192	196 - 205	23	196
241 - 250	20	199	206 - 215	20	196
251 - 260	13	201	216 - 225	22	199
261 - 270	9	200	226 - 235	11	194
271 - 280	5	197	236 - 245	20	196
281 - 290	3	179			

Table II. The mean egg production of the sire's daughters in relation to the mean egg production of the sire's dam and paternal and maternal granddams.

Sire No.	Egg production of the sire's			Daughter's mean production	No. of dams mated to the sire	No. of daughters
	Dam	Paternal granddam	Maternal granddam			
334	270	267	278	249	208	13	69
170/08	254	227	220	247	180	4	14
172	220	270	229	240	219	8	49
170/01	264	222	224	237	198	4	29
368	233	270	226	236	204	10	58
330	213	267	210	230	198	14	84
170/04	234	226	203	228	198	5	26
337	229	220	219	226	142	2	11
338	229	220	219	226	197	18	91
363	219	227	216	221	197	7	44
369	219	227	216	221	179	3	21
270	226	220	167*	216	197	6	32
170/06	226	220	167*	216	216	9	49
331	214	213	223	213	171	11	79
360	227	213	163*	216	197	7	37

*Two maternal granddams represent old birds that were used as breeders prior to the selection of males from 200 or better.

Table III. The mean of the mean egg production of the daughters of each of the dams classified according to the range in mean egg production of the dams' dams and paternal and maternal granddams.

Range in mean egg production of dams' dams and paternal and maternal granddams	No. of dams	No. of daughters	Mean egg production of daughters
200 - 214	36	189	201
215 - 229	34	204	190
230 - 244	21	120	189
245 - 260	6	40	201

Table IV. The mean of the mean egg production of the daughters of each of the dams classified according to the range in the mean egg production of the three nearest female ancestors of both sire and dam.

Range in mean egg production of the three nearest female ancestors of both sire and dam	Mean of the mean egg production of the daughters of each dam
209 - 217	186
218 - 226	197
227 - 235	199
236 - 244	210

Bud Variations in Sugarcane

THE illustrated paper entitled "Bud Variations in CO. 213 Sugarcane" by R. Thomas of the Imperial Sugarcane Breeding Station, Coimbatore, in the *Indian Journal of Agricultural Science,* Vol. II, Part V, October, 1932, is a noteworthy contribution to our knowledge of this important subject. It reviews briefly some previously described sugar-cane bud variations, records the discovery of four striking bud variants of the CO. 213 variety, the performance of progeny propagation of these striking bud sports, and a discussion of the cycle of sports obtained from CO. 213 leading back to the original cane. The color plate showing the characteristics of typical canes and two other plates showing some of the results of progeny tests of these sports, are particularly clear and informing.

Other recent papers in that Journal include one entitled "Sugarcane Varietal Trials for Selecting Suitable Improved Types" by Rao Bahadur T. S. Venkatraman, B. A., I. A. A., Imperial Sugarcane Expert and Syed Abbas Hussainy, in Vol. III, Part 1, January, 1933, and one entitled "Observation on the Cytology of the Sugarcane" by N. L. Dutt, Second Cane-Breeding Officer and K. S. Subba Rao, in Vol. III, Part 1, February, 1933. Both articles present the results of original research work at the Coimbatore station by the authors that are of particular interest and value to those concerned with sugar-cane improvement through selection and breeding.

A. D. SHAMEL.

REVIEWS OF BOOKS

Unsolved Problems of Evolution—A Method of Selecting Female Chicks—Alleged Sex-Reversal in Man—Apple Breeding Up to Date—The More-than-Human Baby Ape

Genes in Environment and Evolution

VERERBUNGSLEHRE mit besonderer Berücksichtigung der Abstammungslehre und des Menschen, *by* L. PLATE. Band II. Sexualität und allgemeine Probleme. XIV + 678 pp., 155 figures. Price, paper covered, 30 marks; bound, 32 marks.

IN the October 1932 number of this journal, a review was published of Vol. 1 of Plate's *Vererbungslehre*, which dealt with Mendelism. The second volume has now been published, entitled Sexuality and General Problems. It appears in the usual faultless press work of Gustav Fischer and contains an orderly presentation and critical review of an enormous amount of literature, chiefly genetic, pertinent to the subjects discussed.

The general viewpoints of the author were set forth in the preface to his first volume, and these remain substantially unchanged. He is still an ardent selectionist and Darwinian but, like Darwin, has Lamarckian leanings which make him regard the riddle of evolution insoluble without a slow and gradual inheritance of environmental effects. He finds random undirected mutations an insufficient explanation of evolution, however long the time scale is assumed to be. Yet, as a Mendelian, he holds firmly to the "purity of the gametes" concept and to the exclusive function of the chromosomes in heredity. The idea of cytoplasmic inheritance he rejects because there are no observable gene carriers in the cytoplasm and no mechanism for their orderly distribution. The idea ascribed to Boveri, Conklin, Loeb, and others, that the general plan of organization (symmetry, metamerism, organ systems) resides in, and is thus inherited in, the cytoplasm, he rejects, arguing that if this were so, varietal differences should also be similarly determined, which is not true, since they mendelize. The reviewer is unconvinced by this argument. To him it seems reasonable that the general features of organization should reside in the cytoplasm (as undoubtedly they do, whatever view we take as to their ultimate source), and yet that chromosomal genes should be able to modify that organization in minor and secondary ways only, just as hormones modify the form and activities of a mammal without changing its fundamental mammalian organization or even its genus and species type of organization. As a matter of fact, only organisms can be crossed which have the same general plan of organization (in their cytoplasm). They may have different chromosome equipments and yet produce vigorous offspring, as the mule, for example, which however fails to reproduce sexually because the mechanism of chromosome conjugation and orderly segregation can not operate to form functional gametes. Polyploidy is the only successful evasion of the barrier.

Hybrid Vigor

Hybrid vigor, Plate admits, is as yet an imperfectly explained phenomenon. He favors a "combination hypothesis," according to which it is due (1) partly to a stimulating effect resulting from the association in the hybrid of plasmas somewhat different in their physical-chemical structure and (2) to favorable gene combinations, which ordinarily do not persist in F_2 and later generations because of recombination of genes with

the occurrence of harmful recessives in homozygous form.

In his examples of species hybrids Plate makes one unfortunate selection, that of "Leporids" as a product of the crossing of the European hare with the rabbit. He describes the supposed hybrids as animals in which the characters of one parent species (the rabbit) are largely dominant. The description of the animals as closely resembling rabbits would be admitted as correct by all, but most observers would go further and maintain that the supposed hybrids are *nothing but rabbits*, since in all critical attempts at hybridization of these two species, by means either natural or artificial, failure has invariably occurred.

Plate holds genes to be the exclusive agency of the cell concerned in inheritance. He defines them as living centers of energy, capable of growth and division, which are located in a definite linear arrangement in the chromosomes, and which accordingly mendelize. Their function is twofold. (1) They are determinants in Weismann's sense, in that they, in some way, compel the cytoplasm to react in particular ways, so that out of raw materials it constructs the different cell structures. (2) They are bearers of heredity (Erbträger) which are reproduced from generation to generation. According to present knowledge, they produce only the varietal characteristics. It appears, however, that outside of the chromosomes in the nucleus they are united in a higher non-mendelizing unit, the "Erbstock," to which is assigned the genesis of the organization-characteristics (Organisationsmerkmale). This seems to the reviewer a forced and highly speculative, though ingenious, method of accounting for non-mendelizing inheritance as nevertheless depending upon chromosomal genes.

The Mechanism of Evolution

Regarding undirected random gene mutation as insufficient to explain progressive evolution, Plate offers the following supplementary hypotheses.

1. The environment acting on the cytoplasm may alter its composition, and this, in turn, may induce new gene mutations, progressive or retrogressive. A long continued and progressive change in the environment may thus have an orthogenetic effect on evolution.

2. The "Erbstock" hypothesis: Gene-complexes determine the type of organization and thereby the higher systematic categories, from genus upward.

3. The inheritance of acquired characters: New inherited characters arise not alone through sudden chance alterations (mutations) in the germ plasm, but also through adaptive somatic changes produced by the environment which are registered also in the germ plasm by parallel induction.

As regards the origin and significance of sexuality, Plate regards it as having appeared first in one-celled organisms as a means of conserving the race by occasional union of individuals too weak to survive separately under existing conditions. Regarding the stimulus to such union, Plate adopts Hartmann's theory of *relative sexuality*, that uniting individuals must be slightly different when graded on a scale ranging from plus to minus. He reviews the literature on bipolar and multipolar sexuality, hermaphroditism, the bisexual state, parthenogenesis, types of sex determination, intersexes, the effects of castration, and indeed the entire field of sex phenomena in animals and plants, a subject the ramifications of which are too extensive for notice in this review.

On the whole this volume constitutes a notable contribution to the philosophy of genetics and evolution, an aspect of the subject too often neglected by the research worker, with his eyes on the solid earth, looking for additional facts. After all, it is the synthesis of facts into generalizations which constitutes the real groundwork of science, and Plate, a veteran in the accumulation of genetic data, is well aware of the necessity for synthesis and generaliza-

tion. In this brief review only the latter aspects of his volume have been touched upon. In reality, it summarizes admirably an enormous amount of genetic research.

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Sex Differences in Baby Chicks

SEXING BABY CHICKS, *by* K. MASUI and J. HASHIMOTO. Pages 91, price $5.00. Journal Printing Company, Ltd., Vancouver, Canada.

A NUMBER of years ago Masui and Hashimoto reported in Japanese that they had found a rudimentary copulation organ in the cloaca of male chicks, and that this structure can be used for distinguishing the sexes at hatching. These observations have been verified since then by Macdonald and Taylor (*Journal of Morphology*, vol. 54, 1933). The Japanese authors now give a very well illustrated and clear description of the appearance of the rudimentary copulation organ in newly hatched chicks and of its development. In early embryos the organ has practically the same appearance in both sexes. In baby chicks the organ shows considerable variability of size and shape; in a small percentage of cases it is, at this age, present in females, but is usually quite small and differs in other ways from that of males. In rare instances, it is very difficult or impossible to distinguish the sexes. In Japan baby chicks are sexed with this method on a large scale, and the accuracy of specialists is said to be at least 92 per cent. It is very probable that many hatcheries and perhaps even individual farmers in this country also will adopt this method, and in this case the book by Masui and Hashimoto will be indispensable for learning the technique. In addition to the report by Masui and Hashimoto (pp. 59-88) there is an introduction by E. A. Lloyd (pp. 13-14) and another one by T. Yamaguch (pp. 43-57). These introductions deal with problems of poultry raising, stressing particularly the desirability for the poultry farmer to be able to purchase female chicks, and with the development in Japan of the application of Masui and Hashimoto's method in practical poultry husbandry. —The price of the book, unfortunately, is unreasonably high.

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Gelding the Lili

MAN INTO WOMAN, Edited by Niels Hoyer, translated from the German by H. J. Stening with an introduction by Norman Haire, Ch.M., M.B. 288 pages, 18 illustrations, price $3.50. E. P. Dutton & Co., Inc., New York, 1933.

THIS book, "Man into Woman," tells the story of the transformation of the Danish painter, Einar Wegener, into Lili Elbe. Einar Wegener was born in the 80's of last century. When about twenty he married and was apparently unremarkable both psychologically and physically as a husband. Some years later, by pure chance, he was persuaded to dress up as a woman and the disguise was so successful and so appealing that thereafter he often pleased himself and his friends by wearing feminine clothes. When so adorned he was given the name of "Lili" by one of his friends. Gradually he became conscious of a change in himself, he felt that Lili was a real individual and the more important, that he was, as it were, both male and female inhabiting one body. Periodic bleedings from the nose and elsewhere he came to regard as a sort of vicarious menstruation. Turning to books on sexual pathology for an understanding of himself, he was led to

the conclusion that though his external reproductive organs were as those of the normal male (though perhaps somewhat small) yet in his body there were the internal reproductive organs of the female.

He was diagnosed as a case of neurosis by some, of homosexuality by others. He was treated with X-rays, and to this is attributed the shrunken state of the organs which were found in his abdomen at a later operation. By the time he was forty he was more than ever wishful to become completely a woman. The doctor who was persuaded that possibly the patient was indeed possessed of both ovary and testis sent him to Berlin where he underwent a series of operations. At the first his testicles were removed. Later, in Dresden, his penis was amputated, and within his abdomen were found what were thought to be rudimentary ovaries. At this time ovarian tissue from a healthy young woman of twenty-six was implanted within him. Later still, another operation was performed in which, though the record is not at all clear, some remodelling of the external genitalia was performed. At last he felt himself to be completely a woman. He was issued a new passport in the name of Lili Elbe and his former marriage was declared null and void. A French painter fell in love with Lili and wished to marry her. Before she would consent, a further visit to Dresden was made, and it was proposed that yet another operation should be performed as a result of which sexual intercourse and pregnancy might become possible. This operation was actually carried out, but shortly afterwards Lili died, apparently of heart trouble.

Through the indiscretion of a friend the secret of Einar Wegener leaked out, and the case was reported in the general press, causing a great sensation, in 1931. The account given in this book is written by the author partly from his own knowledge, partly from material dictated by Lili, partly from her diaries, and partly from correspondence. It is stated that the surgeon who performed the operation has expressed his satisfaction with the record.

As a piece of literature the book is valueless. As a case history it might have possessed very considerable interest, but unfortunately it is very incomplete and the method of recording is highly unsatisfactory, for several most important facts are not made available. For example, there is no description of the results of the histological examination of the sex glands, testes and ovaries, that were removed. In the absence of such information it is perfectly legitimate to exhibit a skepticism and to question whether the organs removed were indeed what they were supposed to be. There is no sufficient account of the condition of the male external genital organs before they were removed, and nowhere is there any suggestion that hormonic examination was made. One is led to infer that oestrin was present in the blood withdrawn, but the account (page 147 "a small instrument, similar to a morphia syringe") does not permit one to assume that the examination was sufficiently thorough. Finally, there is no reference whatsoever that would permit one to know the fate of the grafts and the nature of hormonic production and excretion after their implantation.

Although it is the case that one approaches a story of this kind with the anticipation that the records given will not be sufficient to permit one to accept the story as proven, one also approaches it with a desire that the case that the author makes should be foolproof, for although sex transformation of this kind would seem to be incredible, we do not know enough to hold the view that it is impossible. However, this case is like all the rest; its description and recording are most unsatisfactory, and one seeks inevitably some simpler explanation than the one that is offered. It seems not improbable that this is a record of the psychological condition known as "mother identification." This view is strongly supported by the evidence given in

the book, and the appearance of this condition in what is (if the facts are correct) a hermaphrodite, is probably nothing more than mere coincidence. In a physiologically normal individual early and appropriate psychological treatment would have cured the condition, and, having read the book, no reason presents itself which would force one to think that a similar cure, or at least a marked alleviation of the symptoms, could not have been affected in this particular case. Apparently what was regarded as physiological abnormality led directly to a completely wrong treatment terminating in the death of the patient, which perhaps is just as well for everybody concerned. It is not without interest to note that there is no record of this case, as far as one can gather, in the medical literature. It is very doubtful whether this book in its present form fulfils any useful purpose, though certainly those who are, or imagine themselves to be, similarly abnormal (and of these there are many) will find it most interesting and probably unhelpful. As a scientific record it is definitely poor. As presented the narrative is not a contribution of any importance to pornography, psychology or to physiology.

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The Apple Since Adam

THE APPLE, *by* Sir A. Daniel Hall and M. B. Crane. Preface by Sir Daniel Hall. Pages 235; 22 figures, 6 tables. Price 10s. 6d. Martin Hopkinson, Ltd., London, 1933.

THIS book is written for the "practical man." Starting in the preface with a plea for better cultural methods in Britain, the successive chapters present clearly and directly different phases of the subject as modified by the more recent research.

The historical discussion of the apple in Chapter I is an interesting and readable account. Emphasis is placed upon the long association of man in Europe with the apple and the place of man as a natural agency in its distribution. The reader in this country will follow with profit the setting given the apple in this chapter. In view of the craft skill so evident in England in handling fruit trees, it is a little surprising for the authors to say that "the English have always had to learn their gardening from abroad."

At first thought, it would seem to take courage in addressing the practical man, to devote so much space in Chapters II to V, inclusive, to what are generally considered extremely technical facts about the apple. The authors, however, stress the point that "the better the workman the finer tools he can employ or may even need." The very readable manner in which the results of the more technical research are presented will enable the grower to understand its fundamental bearing upon such problems as the sexual process, vigor, heredity and sterility. This summary of the applied implications of this phase of the more recent studies is especially valuable in view of the leadership of the English investigators in this field and, since this phase of the book is unique, a brief statement of the main facts brought out is justified.

Apple Chromosomes

Chapter II leads off with a discussion of the tree, the flower and the fruit: The complexity of such characteristics as growth, color and quality are there discussed. The treatment of the chromosome theme starts with the cell as the unit of structure in all plants, and builds up through cell division to the relationship of the chromosome to inheritance. Following a brief discussion of somatic and reduction division, the reader is introduced directly to the fact that the body cells of the normal apple contain two sets of 17 chromosomes, or in all a complement of 34. The idea of multiples of the

basic number is then introduced in the discussion of the haploid, diploid, triploid and other multiples of the simpler condition. Illustrations showing the chromosome condition of some of the more important varieties make clear some of the possibilities in chromosome numbers in crosses.

In Chapter III, attention is given to variations and fluctuations. The complexity of the genetic constitution of the apple is shown to stand in the way of "fixing" or producing a seed reproducing variety or strain. The genetic nature of "sports" which arise in the body tissue, without the intervention of the sexual process, is discussed and the relation of the "sport" tissue to the normal tissue is illustrated for the different types of chimeras. It is noted that so far as studied the chimeral tissue in the apple has the same chromosome number as the parent tissue.

Sterility

The basic treatment of sterility, fertilization and incompatibility in Chapter IV will be particularly interesting to American readers. The studies at the John Innes Institution check with the American results in showing a high degree of self-sterility in the apple. This is seldom complete in the varieties listed, but is nearly commercially so. On the other hand, the authors show an interesting increase in the percentage of fruits to mature in cross pollination tests as compared with the self-pollinations—the fertility ratio being 10.9 per cent in the former and 2.6 in the latter. The influence of the chromosome content upon fertility is followed in crosses between diploids, diploids and triploids, triploids selfed, etc., and this fundamental background is shown to have an important bearing upon imperfect cropping in commercial plantings. When this relationship is followed further it is found to have a bearing also upon such important factors as pollen viability and seedling vigor. In the extremely complex problem, therefore, of fruit setting and fruitfulness, generational inferiority, that is, the imperfect balance between the chromosomal complements from the pollen and pistil parent, is shown to have an important influence.

In Chapter V, on breeding, the discussion centers around the chromosome constitution of the parents—following this type of treatment quite naturally from the preceding chapters. The expectations of character inheritance, when the single, double or triple, etc., are present, are illustrated with horticultural material. In this way the complexity of the inheritance of such characters as color, size, shape, quality and disease resistance can readily be shown to the layman. With this knowledge as a background the variations in the apple so universally met with wherever seedlings are grown can be understood by the apple grower.

The chapters on the cultural phases of the subject (VI to IX), inclusive, can well be read with profit by American horticulturists. Emphasis is placed upon the wide range of soil types upon which the apple will thrive providing drainage and other conditions for a good site are met. The best soils, however, are considered to be lighter, well-drained loams. Chapter VIII will be especially interesting to horticulturists because in it there is given a summary from the applied standpoint of the experiments in England with the different root stocks. These are presented in relation to their dwarfing and fruiting effect upon the tree. The place of this phase of the propagation problem is yet to be determined in American orcharding. It should be stated, however, that there is much promise commercially from this angle upon which the English investigators have placed so much emphasis.

The final chapters on pruning, diseases and spraying, and varieties, picking and storage, deal particularly with English conditions, that on pruning especially being quite different from the usual practice recommended in this country for commercial conditions. It may be that a combination of the root stock-pruning type of special treatment

so commonly in use in the more restricted plantings in English gardens might profitably be used with filler trees in this country.

Finally it may be said since the authors intended this treatise on apple growing for the practical man that they have admirably accomplished their purpose. It should be of interest to American horticulturists to find a book of this type addressed to growers whose craftsmanship in handling plant material is still so largely motivated by the amateur spirit. A foundation thus laid might easily broaden out to the commercial proportions stressed in the preface by Sir Daniel Hall.

University of Illinois M. J. Dorsey

In Praise of Our Monkey Cousins

THE APE AND THE CHILD, *by* W. N. Kellogg, Associate Professor of Psychology, Indiana University, and L. A. Kellogg. Pages 341. Illustrations 80. Price $3. McGraw-Hill, New York, 1933.

THIS book is an account of an attempt to see how far an ape, reared in an entirely human environment, can become like a human being. Brought up with a human baby several months her senior, she goes through all the experiments to which this child is subjected. Dressed in rompers and shoes, sleeping in a bed, eating with a spoon in a high-chair, drinking from a glass, little Gua shares all the experiences of Donald. And Gua nobly responds by doing all these things better than Donald. In other words, her environment makes her more human than a human being can be. The experiment is discontinued after nine months and Gua is returned to her cage.

I found the book a fascinating one, and read it through at one sitting. This is perhaps because I enjoy watching the activities and development of children and animals. I appreciated thoroughly the descriptive style in which the records were made. Reducing personalities to percentages, with an occasional probable error thrown in, does not reveal the developmental trends of babies.

Genes of Monkeys and Men

The authors have concluded from their experiment that certain trends of development in the ape were purely dependent upon the environment, such as eating with a spoon, or walking upright. Heredity is shown not to be the entire basis of development. With this conclusion, I am sure that even the most rabid of the protagonists of the theory that heredity is more potent than environment would agree. Certainly they would not claim that there was a gene for eating with a spoon, which would make the possessor thereof eat with a spoon, even were there none to eat with. We can imagine a child in a desert who has never seen a spoon eating without one. The believer in heredity would, however, maintain that what was inherited were certain structural configurations of muscle and bone in the forearm, which permitted of pronation and supination of the arm, thus enabling the ape as well as the child to eat with a spoon once it had been taught. That Gua learned to walk upright was also dependent upon her having been taught, in other words upon her environment. It was even more dependent upon certain anatomical peculiarities of the junction of the pelvis with femur, which permitted her to assume the upright position.

We all agree that environment profoundly modifies our existence. Many of our hereditary tendencies are dependent upon environment to elicit them. A duck has an inherited capacity for swimming, but it takes a little water to bring that ability out. We inherit certain potentialities for developing along well defined lines, provided we are in the proper environment to bring those capacities to the fore. If opportunity is not provided for the expression of those capacities,

we may remain unaware of their existence. Therefore we are not in the least surprised that Gua's environment modifies her reactions, and enables her to accomplish acts which she would never have performed had she been left in her cage. These acts, however, depended upon her structural likeness to the human child.

Rates of Learning

Gua learned more rapidly than Donald; this is not because the child was slow, or because Gua was unduly fast in learning. It depended entirely upon the different developmental rates of the two organisms. Kellogg notes this faster maturation in the ape, as explanatory of the greater agility of the ape, and its capacity to learn faster; although he points out that more rapid maturation and faster rate of learning are not functions of one another. If they were, he says, then the dog, which matures much faster than the child or the ape, should be able to perform certain of the human acts at an age much earlier than either the ape or the child.

He neglects to point out that such is the case. For example, the new born kitten or puppy knows enough to move its head around until its mouth comes into contact with the nipple which means its food. The human infant, on the other hand, often has to be taught to suck even after the nipple is placed in its mouth. Again, Gua was 13 months old before she became much of an adept at sphincter control, and notification of her desire to void. Kittens or pups not more than six weeks old have been taught that lesson, and by no methods that were not suitable for instruction of a child. Thus maturation does influence the ability to learn; but it is heredity which marks the extent to which the learning process can be carried. The ape learned more quickly than the child; but had the experiment been carried out further, its limits of teachability would have been reached much sooner.

Limits of Learning

The authors point out that although it would have been desirable to continue the experiment longer, the ape might have still been in the lead in its capacity to learn; and that the criticism might always be leveled that had it been kept up a little longer, the child would have won out. To prove anything by such an experiment, it should have been continued until such time as the child was showing traits only shown by human beings. During the first two years of the child's life it is doing for the most part only what animals can be taught to do—to walk, to coördinate its motor activities, to learn sphincter control, to feed itself, etc. All these things an animal learns in an animal environment. The experiment should be carried on until the child is going to school, has learned to read and write, to deal with numbers, not only by way of recognition, but through intellectual processes with them; has learned to speak, to combine words into sentences and sentences into paragraphs. Let us suppose that the ape was able to keep pace with the child in all these subjects; we are still brought face to face with the fact that the ape learned them because he had a heredity which enabled him to learn these things. A cat or a dog could not have done so in a similar environment; their heredity would have limited them.

The experiment was interesting, but the conclusions are, to my mind, not those that the authors might like to have drawn. It did not show how human-like an ape can be made to become in a human environment; it clearly demonstrated how animal-like the human being is in the first few years of his development.

One more word—that of a sentimentalist, not of a scientist. My sympathies were all for little Gua who, learning to depend so much upon human affection and care, was put back in a cage, deprived of her freedom and the friendship of man.

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THE EASIEST PLANT IN THE WORLD TO PROPAGATE

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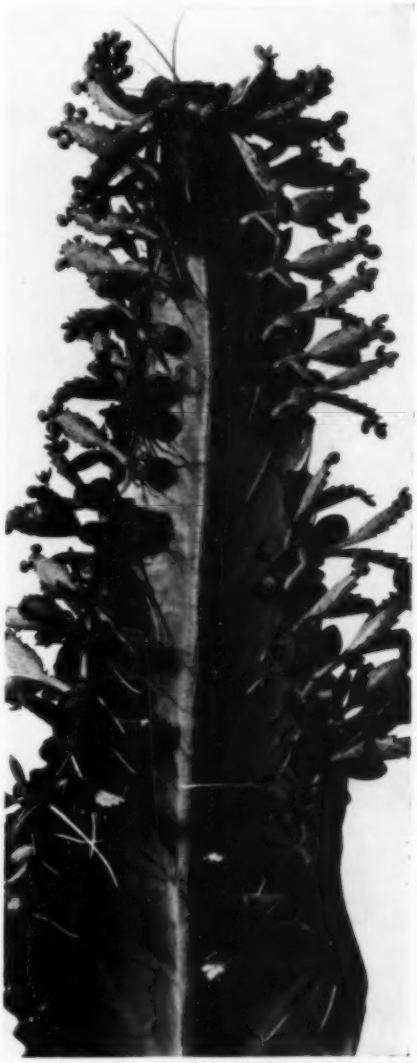
IN this Journal have appeared from time to time accounts of the techniques for the propagation of plants that for one reason or another have proved not amenable to the more usual methods. As a relief from the complexities of these more difficult methods it may be of interest to put on record some facts about the propagation of *Kalanchoe daigremontiana*, the easiest plant in the world to propagate.

K. daigremontiana is an interesting succulent, introduced to this country from Madagascar by the author in 1928. Figure 5 shows how, in a quiet greenhouse with abundant plant food and high air humidity, the "grandchildren" may become very much in evidence even before the first pseudobulbils have dropped from the serrations of the main leaf. It is obvious that with 20 to 40 main leaves, 50 to 100 serrations to each (every one with a new plant) and some half dozen individuals of the third generation on each of the second generation "plants," one plant of *K. daigremontiana* can, by its normal propagative activity, leave a truly remarkable number of vigorous offspring in the course of a single season.

Figure 6 shows another interesting phase of the life of this plant. The normal vegetative activity is supplemented by a new type, and the superabundant vegetative propensities of the plant, held in check for a while by the flowering activity, have reasserted themselves. After the seed had set, the old flower stalk formed both vegetative and adventitious floral structures at the same time. One frequently thinks of vegetative reproduction as being more or less synonymous with restricted seed production, as, for example with the potato. *K. daigremontiana*, however, alternates a well-defined season of vegetative reproduction coinciding with that of growth in size with a definite flowering period during which there is little



Photograph by L. A. Guernsey

THREE "GENERATIONS"

Figure 5

Leaf of the easiest plant to propagate showing daughter and granddaughter plants.

TWO KINDS OF REPRODUCTION AT ONE TIME

Figure 6

Flower stalk of the "botanical guinea pig" showing seed capsules, a young vegetative plant, and an adventitious flower.

or no vegetative growth. Even without such phenomenal reproductive activity this plant would be considered easy to propagate on account of the abundant viable seed it produces; yet in one common type of reproduction it is deficient: it does not sucker from the roots.

Although extremely easy to propagate, *K. daigremontiana* and all the others of this group have one rather definite requirement: they demand a high atmospheric humidity for satisfactory growth. For this reason it is very hard to grow them in a furnace-heated house unless special precautions are taken to moisten the air. Though there must be moisture in the air surrounding the leaves, the roots require very little and the plant can live for months or even years without appreciable water in the soil.

Largely because of its ease of propagation *K. daigremontiana* has proven itself far superior to *K. pinnata* (or *Bryophyllum calycium,* as it is commonly called) as a plant for testing the virulence of the germs in studying the crowngall diseases of fruit trees. In addition it is wholly immune to injury by red spider, mealy bug, scale, and all the other pests that cause so much trouble in growing large numbers of trial plants.

The very ornamental *K. daigremontiana* might well be likened to the guinea pig because of its reproductive propensities and, in the experimental sense, it is rapidly becoming the "guinea pig" of the plant kingdom.

X-RAY MUTATIONS IN THE TOMATO

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STIMULATED by the early successes of Stadler[2] in inducing mutations in barley a similar experiment was set up in 1929 with seeds of the tomato and spinach, and some tests were also made with hen's eggs to try out the theory then current that sex might be transformed and chick growth accelerated by radiations. The results with the fowl* and with spinach† were apparently wholly negative, but an interesting series of mutations was induced in the tomato.

Forty-three fairly distinct mutants, mostly new to the species, appeared in recessive ratios in the progenies of plants reared from the treated seeds. Among them were several kinds of mutations that seem quite unlike any yet reported as induced by X-rays in other plants, even in the allied tobaccos, or by radium in the tomato itself.[1]

Treatment of the Seeds

Seeds (Vaughan's Earliana) harvested in 1928 were mixed thoroughly and seven samples of about 1000 seeds each were withdrawn, one for control and six for exposure. The treatments were given by Dr. A. C. Singleton, through the courtesy of the Department of Radiology of Toronto General Hospital. They consisted of exposure under a Coolidge tube, operated at 90 K. V., with line voltage of 110, a tube current of 5 m.a., at a target distance of 25 cm., without any filter. The lots were exposed for 9 minutes, 18', 27', 36', 46½', and 60' respectively, the maximal dosage being 14½ "erythema doses" (each approximately 1200 r-units). The dry and wholly dormant seed was spread thinly on paper and stirred from time to time during exposure.

Plants were grown from control and treated seeds in a greenhouse and out of doors, isolated from other tomato plants, and naturally selfed. Single fruit progenies of thirty or more each were started in flats and closely inspected for variant types evident in the seedling stage; twenty progenies were examined at full maturity but no further flower or fruit mutations were noted.

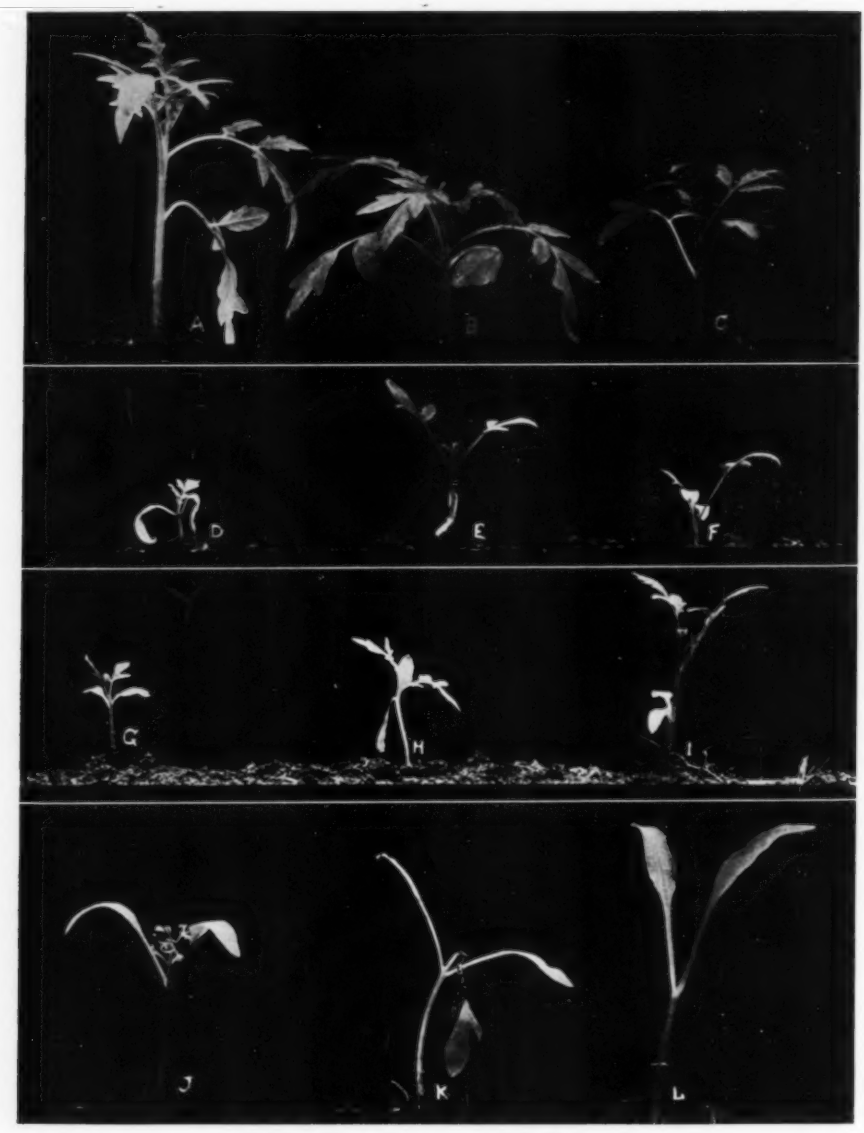
Changes Induced

The percentage of germination was high and nearly equal (95%) in the control and all the rayed seeds. About 600 control seedlings and 1200 from X-rayed seed were seen; among the latter were eight bright yellow-white chlorophyll deficients, which died without forming leaves; whether these were cytoplasmic or dominant lethal changes is not known. The other control and X_1 plants appeared wholly normal; those carried to maturity varied little in fertility, and every one set seed freely. No chimeras were seen; evidently the young plant resting in the seed consists typically of one unbranched axis.

None of the 100 control progenies produced any exceptional seedlings more remarkable than the fluctuations in size, form or color usual in

*Eggs from Barred Rock hens mated with a Brown Leghorn cock were X-rayed and incubated. With increasing dosage from 1250 to 5000 R. U. dead germs increased rapidly to 100%; the chicks hatched were sexed (26 ♀♀ : 22 ♂♂), but showed no significant departure from the normal sex ratio: the pullets were all marked by the expected sex-linked characters (non-barred, and fast-feathering), the cockerels by barred (white on the nape) and slow-feathering; and the average growth rate was not exceptional.

†Due possibly to incomplete testing (40 progenies), to polyploidy, or to tolerance of the 60' dosage found effective in the tomato.



MUTATIONS INDUCED BY X-RAYS

Figure 7

Twelve seedling mutations in the tomato induced by X-ray treatment of the seeds one generation before. The plants that grew from the X-rayed seeds and that reached maturity appeared to be normal. These plants were grown under isolated conditions and naturally self-pollinated. In 346 progenies from these plants 43 mutations appeared. About 25 of these have been studied in detail and behave in inheritance as Mendelian recessives. The plant at *A* is of normal growth. All plants were the same age when photographed. For details see text.

"CURLY" AND "SLOW GROWING" MUTATIONS

Figure 8

The Curly mutation (*A*) has very much altered foliage and grows rather poorly, as is shown by comparison with a sister plant of the same age (*C*). The "slow-growing" mutant (*B*) has yellowish-green foliage. Its growth rate is to be compared with a normal-growing plant from seed from the same fruit, at the left.

any tomatoes. Those from each of the two treated lots tested have revealed a number of definitely transmitted novelties, besides a number of more doubtful and ephemeral changes that have not been faithfully reproduced in later generations or repeated in further samplings from the same X_2. In all, 43 mutations were found in 346 progenies (12.4%); one progeny had two mutations.

The number of mutations induced is clearly related to dosage, for the 60′ exposure caused 30/189, or 15.9% mutations, and the 46½′ exposure 13/157, or 8.3%. An even greater dosage than that used might be more effective since the lethal point was not closely approached, the germination and the fertility remaining quite normal in both X_1 and X_2 generations. It seems possible that gene mutations are relatively more frequent with moderate and sublethal doses.

The changes induced were of the most varied nature, involving the color of foliage and stem, shape of the leaf, stature, branching habit and growth rate. As has been the usual experience, the majority of the mutants exhibited some disturbance, often very striking, in the chlorophyll system; the cotyledons (and at least the first leaves in most cases) were white-dotted or mottled, grey-edged,

or variegated in five mutants, striped in two, brown-speckled in one, bright yellow in four (Figure *7D*), some grade or pattern of light yellowish green (Figures *7G, H,* and *8B*) in ten others; deep purple and glossy in two (Figures *7C* and *7I*). The most marked of these were lethal, and none was really virescent.

In three cases the stem color was changed to green (Figure *7A*), and two of these proved on intercrossing to be identical with the known "green stem." Several kinds of paler or intensified (purple or brownish) pigmentation accompanied mutations more marked in other characters.

The form of the cotyledon was altered in some; to slender-short in one, and long in one (Figure *7E*); to short and broad in two, to curved or rolled in four. One progeny had 25% polycotylous seedlings, but this trait seems to be unfixable. The leaf shape in one mutant is broadened and vaguely resembles the potato leaf; in another it is curly, with reduced, narrowly dissected, and antler-branched parts (Figures *7J* and *8A*).

There were two changes to ultra-dwarf types, both very different in foliage from either of the known dwarfs. Another mutant, somewhat similar in appearance to brachytic (Figure *7B*), is partly sterile, and has a whorl-like leaf arrangement and widely sprawling lateral growth. Several more mutants are characterized solely (as yet) by a greatly reduced growth rate and a small, even stunted appearance (Figure *7F*).

Perhaps the most noteworthy and novel of the mutants are those in which the apical growth has been locally affected. At least three of these, all different in minutiae, are decapitate; they form the first leaves normally but then the stem begins to wither and die off subapically (e. g., just above the base of the cotyledons), the yellowing crown growth falling down of its own weight (Figure *7K*) and the death of the rest of the seedlings proceeding downward. Another mutant typically lacks any sign of a growing tip (Figure *7L*) and ultimately forms enormously swollen cotyledons, or after much delay may send out normal leaves.

It is not yet possible to say how many of these mutations have been duplicated or which, if any, belong to multiple allelomorphic series. Probably only green stem and possibly brachytic are repetitions of genes already known.

About 25 of the most promising (most viable or most distinct) types have been selected and repeatedly cultured for cytogenetic study of pollen, chromosomes, and linkage. Such as prove their genetic value will be further described, named, and given symbols.

In general these mutations are all recessive and monofactorial, and are probably chiefly point mutations. Over a half are lethals, and must be maintained "blindly" by selfing normal-looking plants to locate heterozygous carriers. Many of the others are semi-lethal, leading a more or less precarious existence in the homozygous state. Only about twelve can be regularly cultured pure. All but a few are slow growing, weak or stunted, and tend to show some deficiency in numbers in F_2 or backcross generations. Unexpectedly few are sterile or semi-sterile. While several are normal in vigor, and one may be taller than normal owing to elongated internodes, there are no giants or faster growing types and no valuable flower or fruit mutants, in short no superior types of obvious economic value, but a number of curiosities that should be useful mainly in expediting the genetic analysis of the tomato. For this purpose they provide a welcome supplement to the 25 or 30 genes hitherto known.

Literature Cited

1. Lindstrom, E. W., 1933. Hereditary radium-induced variations in the tomato. *Journal of Heredity*, 28:128-237.

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A Glossary Of Genetic Terms

GENETICS has developed so rapidly that many terms in common use in genetic literature are not yet incorporated in the dictionaries. Many people who are interested in heredity are bothered by such words, for which no definition can conveniently be found. For this reason, it is proposed to publish occasionally a glossary of terms which would not be readily understood and which are not to be found except in new unabridged dictionaries. It is realized that these definitions will probably not meet with universal approval and comments and suggestions will be welcomed.

BACKCROSS—Cross of a hybrid to one of the parental forms.

CHARACTER (a contraction of characteristic)—A term used, often rather vaguely, to designate any form, function, or feature of an organism. The Mendelian characters of genetics represent the end-products of development in which a definite gene, or genes, have a decisive effect. "The constant and unchanging thing, therefore, is the factor (gene) itself rather than the character, and the unity which Mendel observed lies rather in this underlying factor than in the visible, and perhaps variable, character which it produces."—Sinnott and Dunn.

CONJUGATION—Side-by-side association of homologous chromosomes previous to formation of genetics.

DIPLOID—Having two sets of chromosomes. Body-tissues of higher plants and animals are ordinarily diploid in chromosome constitution. See *Somatic*.

DOMINANT—A character possessed by one of the parents of a hybrid, which appears in the hybrid to the exclusion of the contrasted character from the other parent (the recessive). Thus in a cross of green- and yellow-seeded peas the first generation has yellow seeds. Yellow is dominant and green is recessive, being transmitted but not appearing in the presence of the factor for yellow.

FACTOR—Same as *Gene*.

F_1—(Pronounced eff-one). The first filial generation. The offspring of a given mating.

F_2—The second filial generation. Produced by intercrossing or self-fertilizing the F_1. The inbred grandchildren of a given mating.

GAMETE—A reproductive cell of either sex; e. g. sperm or ovum.

GENE—(1) The unit of inheritance, which is transmitted in the germ cells, and which by interaction with the genic and cytoplasmic complex controls the development of a character. The genes are arranged linearly in the chromosomes. (2) "The physical basis of heredity"—or more figuratively, the atom of the genetic molecule.

HAPLOID—Having the reduced number of chromosomes, as in germ cells, as distinguished from from the diploid or double number of chromosomes in normal somatic cells.

HETEROZYGOUS—Containing both genes of an allelomorphic pair, or two genes of an allelomorphic series. Heterozygous individuals generally resemble the individuals homozygous for the dominant character, but they transmit the recessive to half their offspring.

HOMOZYGOUS—(1) An organism formed by like germ cells; (2) An organism is said to be homozygous for a given character when all the germ cells transmit identical genes for this character. This is the most frequently used meaning of the term.

LINKAGE—Association of genes in inheritance, due to the fact that they are in the same chromosome.

MONOZYGOTIC—Originating from a single fertilized egg cell, which in the course of subsequent development has given rise (by fission) to two or more individuals. Twins (or triplets, etc.) of such origin are, barring mutations, genetically identical.

MUTATION—Where a heritable variation begins. A sudden variation in an inherited character.

PARTHENOGENESIS—The development of a new individual from a germ cell without fertilization.

POLYPLOID—Normal body cells of the higher plants and animals have two sets of chromosomes (see *Diploid*). Polyploids are forms having three or more of these basic chromosome sets.

RECESSIVE—See *Dominant*.

REDUCTION DIVISION—The division preceding the formation of gametes, in which the chromosome pairs separate, and the chromosome number is reduced to half the somatic number.

SEGREGATION—Separation of allelomorphic genes at meiosis.

SELFED—Self-pollinated.

SOMATIC—Resembling body tissues in having a paired set of chromosomes, one set from the female parent and one from the male, as contrasted with germ cells having a single set of chromosomes.

TRIPLOID—An organism characterized by having three times the reduced primary chromosome number.

Comments from the Questionnaires

To gain some direct information regarding the feeling of members toward the JOURNAL *a questionnaire was sent with the 1934 bills. The responses have been most interesting and very gratifying. Possibly when the returns are all in there may be enough of general interest to justify a note in the* JOURNAL *as to the division of opinion regarding such controversial subjects as the glossary, which present returns indicate is about equally valued and despised. The more general comments under "remarks" have been, with few exceptions, most enthusiastic and encouraging. Some of them are here reproduced.*

"I think you are doing excellently well. Your field is a big one. I feel that articles which are mere reports on minor points (such as the announcement of a new hereditary factor) should be kept relatively brief, while matter of fundamental theory, technique, or work with important implications should be quite fully covered."

"I enjoy the JOURNAL very much but am uncertain as to its purpose. It is too small to present detailed researches or observations. Why not recognize this? The articles listed above are very interesting but I would prefer them in other journals where as much as eight or ten pages are required."

"I am undecided; I hear the JOURNAL criticized for being too popular, (general) not technical. I believe its mission is to give facts of research and opinion to those not highly trained technically in genetics. I find it *now* the *most useful* journal in teaching genetics."

"I am satisfied *as it is!* I hope the questionnaire won't stampede you into any radical change."

"One of the most essential things at present is a suitable publication outlet for research and I would favor curtailing other features if necessary to give space to research articles of permanent value. I appreciate, of course, the educational needs and value of articles for public discussion of questions having popular interest. Short articles of this kind are likely to have a wider appeal than long ones."

"I approve the present trend to encourage the study of human heredity as well as that of economically important plants and animals."

"Along with results of research more articles discussing present situations and problems."

"Don't wander further into the field of sociology or economic aspects of eugenics. Opinion predominates over ascertainable fact there, and the resulting controversies settle nothing. The present policy in this is about right but should certainly not deviate any *further* into this field, no matter how enthusiastic some advocates of complete social planning of all affairs may become."

"For my purpose, I prefer more space given to the plant side. The animal side is getting six or more times as much space as the plant side. Condense the papers some on animals; also some of the long ones on plants. Give us more wheat, less of the chaff."

"While I value the JOURNAL highly because it does cover a broad field, I would like to see more short articles on inheritance in crop plants than have appeared during the last year or two."

"I like the JOURNAL just as it is. I shall continue to pull in my belt so that I may subscribe for it, be the depression ever so long. I like to read the JOURNAL, but I'd continue to subscribe for it if it bored me stiff because I think the people behind it are engaged in a most important job, and I consider it a privilege to help a tiny bit."

"Prompt publication of issues (congratulations on the effort during the past year to catch up with the calendar). A more impersonal attitude on the part of some book reviewers."

"Hell, I don't know, I'm neither a scientist, nor a journalist. I've been reading the JOURNAL since it first came out. I'm just a bum country lawyer (once for 20 years a judge). Reading the JOURNAL gives me a chesty feeling of going along with the big boys of science. There is something impersonal and real about your work as compared for instance to the dirty businesses of money making and politics."